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ARTICLES

Quantitative Determination of Diterpene Acids in Garden Sage Leaves

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Abstract—A procedure is developed for the quantitative determination of diterpene acids in garden sage leaves by UV spectrophotometry at the wavelength 285 nm. The target group of compounds was selectively extracted by petroleum ether 40/70. It was shown that the completeness of extraction is determined mainly by the number of portions of the pure solvent: at the optimum ratio of the mass of the weighed portion to the volume of solvent 1 g/200 mL, double extraction is sufficient. The duration of each extraction is 20 min. The procedure was used in the analysis of samples of garden sage leaves from various producers. It was found that the concentration of diterpene acids in samples varied from 2.1 to 3.6 wt % (in terms of carnosic acid). The error of a single determination of the sum of diterpene acids in garden sage leaves is ±2.38% ($P = 0.95$).

Keywords: garden sage, diterpene acids, carnosic acid, spectrophotometry, standardization, petroleum ether
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Garden sage (*Salvia officinalis*) is known in medicine, first of all, for the anti-inflammatory and antimicrobial properties, determining the efficiency of preparations on its basis in the treatment of infectious and inflammatory diseases of throat and mouth cavity [1–3]. Leaves of *S. officinalis* are a constituents of teas "Grudnoi sbor no. 3," "Sal'varom" (mixture for inhalations no. 1), "Elakosept," etc., and their extracts enter into the composition of complex preparations ("Shalfei" pastils, "Parodontotsid," "Stomatofit," etc.) [4].

Salvia officinalis is a source of a great number of chemical compounds, possessing unique and diverse structures and a wide range of biological activity. Substances of terpenic and phenolic nature, such as diterpenes, tannins, hydroxycinnamic acids, flavonoids, etc. [5, 6] play the key role in the formation of anti-inflammatory, antioxidant, and antimicrobial activity of garden sage leaves. The most famous and widely studied representatives of these groups of compounds are carnosic acid and its derivatives, and also caffeic acid oligomers (rosmarinic acid, etc.). At the same time, the medicinal plants are a source of essential oils, exemplified mainly by mono- and sesquiterpenoids [7].

In domestic standard documents, the analyzed raw materials are traditionally standardized just by the quantitative concentration of essential oils, which is determined according to the requirements of the general pharmacopoeia article "Determination of the Concentration of Essential Oil in Medicinal Vegetable Raw Materials and Medicinal Vegetable Preparations" using the method of wet distillation [8]. It was also proposed to standardize garden sage according to the concentration of the sum of diterpene acids [9] by the procedure based on the extraction of biologically active substances (**BAS**) from garden sage with acetone followed by the extraction and purification of the diterpene fraction and determination of concentrations by spectrophotometry at 285 nm. Calculations were performed using specific absorbance $E_{1\,\mathrm{cm}}^{1\%}$, found for a standard sample of carnosic acid dissolved in ethyl alcohol [9].

In the standardization of garden sage leaves by the concentration of BAS responsible for the main pharmacological properties of the raw materials (in particular, diterpene acids), there is a probability of obtaining unreliable results. This is, on one hand, due to multistep purification, leading to the loss and decomposition of the substances to be determined and underestimation of the results of analysis, and, on the other hand, with a possible presence of polyphenolic BAS in the solution, which absorb light at the same wavelength as the analytes.

The aim of this work is to develop an advanced procedure for the quantitative determination of diterpene acids in garden sage leaves.